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# SKYLAB—Part 2

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HEARING  
BEFORE THE  
COMMITTEE ON  
AERONAUTICAL AND SPACE SCIENCES  
UNITED STATES SENATE  
NINETY-THIRD CONGRESS  
FIRST SESSION  
ON  
REPORT OF SKYLAB 1 INVESTIGATION BOARD

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MONDAY, JULY 30, 1973



Printed for the use of the  
Committee on Aeronautical and Space Sciences

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He was a member of the President's Committee on the National Medal of Science; and of several Presidential Task Forces, the most recent being the Task Force on Higher Education.

He is a Fellow of the Institute of Electrical and Electronics Engineers, an Associate Fellow of the American Institute of Aeronautics and Astronautics and a member of the Board of Trustees of the Theodore von Karman Memorial Foundation. He is a Fellow of the American Academy of Arts and Sciences and of the American Astronautical Society, a member of the Cosmos Club and a member of the Board of Governors of the National Space Club.

He received the first Distinguished Alumni Award to be given by California Institute of Technology and an Honorary Doctor of Science Degree from the University of Utah. Dr. Fletcher served higher education as a member of the Executive Committee of the National Association of State Universities and Land Grant Colleges.

He is the fourth man to head the nation's civilian space agency which came into being October 1, 1958. The first Administrator was Dr. T. Keith Glennan, then president of Case Institute of Technology, Cleveland. He was succeeded in 1961 by Mr. James E. Webb, a former Director of the Bureau of the Budget and Under Secretary of State, who served until 1968. Dr. Fletcher's immediate predecessor was Dr. Thomas O. Paine, who resigned September 15, 1970, to return to the General Electric Company after heading NASA since October 1968.

Dr. Fletcher is married to the former Fay Lee of Brigham City, Utah, and they are the parents of four children, three girls and a boy: Virginia Lee, Mary Susan, James Stephen and Barbara Jo. The Fletchers reside at 7721 Falstaff Road, McLean, Virginia.

#### STATEMENT OF DR. JAMES C. FLETCHER, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. FLETCHER. Well, Mr. Chairman, I had planned to start that way. As you know, all three crewmen suffered from motion sickness yesterday, and particularly the pilot, Jack Lousma had motion sickness very early, and took anti-motion pills, so to speak. And he has had the most trouble. By last night, however, the other two members of the crew were feeling much better. They were instructed to also take the motion sickness pills, and by nightfall had been feeling much better.

We do not have a late reading on them this morning, but it is likely that Lousma will be recuperated. It generally takes one on this sort of thing on the order of 2 days to recover, and we have quite a vigorous training program to adapt them to zero G's. So, it does not help to just lie prone, and you have got to get used to working in the workshop. And they will do this. They did quite a bit of work yesterday afternoon, and they will continue to do it again today.

It will probably delay the deployment of the twin pole sail. Remember, we were going to deploy an additional protection. It was planned for tomorrow. It will probably now occur on Wednesday.

The CHAIRMAN. Do you have any explanation or theory as to why the first crew apparently suffered no motion sickness and, in fact, it seems to me that they reported it was very unusual that they did not have any at all?

And now this crew, all three of them have it.

Dr. FLETCHER. I do not have any explanation because I do not happen to be an M.D. But, one explanation has been volunteered, for what it is worth, and that is, that the previous crew just had to function well because the workshop was in bad repair, and they had quite a heavy load at the beginning of their program, and not only that, they had great difficulties getting there.

They tried to deploy the solar panel without success, and then they tried to dock three times without success before they finally made it. So, they just did not have time to get sick on the last flight. And that is the theory.

The CHAIRMAN. Maybe that is it.

If you are too busy to be sick you will not be sick.

Well, we appreciate that informal report on the progress now in the Skylab workshop, and the fact that the mission has been extended to a longer period indicates a great confidence that the crew will be able to do its experimental work up there.

But, you may proceed now, Mr. Fletcher, if you will, please.

Dr. FLETCHER. Well, I do appreciate the opportunity to be here this morning and to comment briefly on our reactions to the Board's findings and its recommendations.

I would like to join with you and take this opportunity to compliment Bruce Lundin and the members of the Skylab 1 Investigation Board, particularly for the thoroughness and the technical excellence of their investigation, and the timely completion of their task. It was an extremely well-done report.

We all realize the failure that occurred during the launch phase of Skylab 1 should not have happened. However, it did happen—and the two questions NASA has to answer are: (1) Why did it happen? and, (2) What can we do to prevent a similar situation from happening in the future?

The Skylab 1 Investigation Board concluded that a failure of communications among engineering personnel in various disciplines, particularly between the aerodynamics and design, was the basic cause of the design deficiencies which led to the loss of the meteoroid shield and the subsequent damage to Skylab 1. As stated in my letter of July 19, I have accepted these findings.

In NASA we deal with extremely complex systems and have had, by all standards, an extremely high ratio of success to failure. Nevertheless, a few failures do occur and when they do we inevitably find that somewhere along the line we simply did not ask the right questions. We have formal management review procedures, both written and oral, which give our people in industry and Government, at all levels, the opportunity to ask questions about our systems. In almost every instance those procedures, formal and informal, identify potential problems and there is then no question that they are resolved. Unfortunately "almost" is not enough and in this instance we missed—not through negligence but through an oversight—and the right question this time was not asked.

The second major question we must ask ourselves is what we can do to prevent this from happening in the future. It is not enough to say that the identical failure will not be permitted to happen again. That is easy. We cannot dismiss the question because another Skylab orbital workshop of the same configuration will never be launched. We have to learn the full lesson of this failure for the conduct of all our large and complex projects, and see that everything possible is done to prevent the recurrence of a similar oversight.

We have already taken steps toward this goal. We established an independent Investigation Board, have accepted the Board's report,

and have directed projects in light of this. He is committed to look at to see that it is required.

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and have directed all our program and project people to examine their projects in light of the findings of the Board. As Mr. Lundin mentioned, he is one of the recipients of his own Board's report. Now he has to look at his own projects in the same light. We will follow up to see that changes in formal management systems are made when required.

But even more important is the point made strongly by the Board that we should not place full reliance on formal management systems to detect anomalies, deficiencies, and potential problems. I agree wholeheartedly with this finding. We have to do everything possible to insure that we have the right people in the right places to continue to ask the right questions. This is a matter of leadership from the top. George Low and I intend to provide that leadership.

Mr. Chairman, as I have said the failure of the meteoroid shield and the resulting loss of solar array system number two should not have happened, but nevertheless it did. However, as you say, the Skylab 1 and 2 missions as a whole—far from being a failure—have been a resounding success. It is well to remind ourselves of that.

The initial failure brought out the real worth of the NASA team. For 10 days Skylab was in a state of crisis. It could have been a complete failure, but we were able to save it. For example, through an extensive and rapid concentration of efforts, we were able to come up with several sunshade devices to alleviate the temperature problem, and I described those to you 5 or 6 weeks or, no, it has been 8 weeks ago, one of which was successfully deployed by the Skylab 2 crew shortly after docking with Skylab, and another as I mentioned is scheduled to be deployed by the Skylab 3 crew tomorrow. With extremely simple tools, pruning shears, rope, and a collapsible tent pole, the Skylab 2 crew was able to free and deploy the remaining solar panel, giving enough power for normal operation. Finally, by the judicious use of a hammer, Pete Conrad was able to restore an important battery supply which had stopped working early in the mission.

We were able to save Skylab because of the tremendous depth and breadth of the NASA team and the dedication and skills of the thousands of people on that team. There certainly isn't another country that could have reacted as we did. I doubt whether there is another team within this country that could have reacted in this manner. Our team could do it because of years of training, working hard on highly exacting projects, and working as a team to drive toward a technical objective. The performance of the team on the ground, and of course, the magnificent performance, skill, and courage of the astronauts, saved Skylab. I would hope that this is remembered as the real story of Skylab, not the failure which caused it to happen.

In summary, Mr. Chairman, we had a failure which should not have happened. We had it thoroughly investigated and found that it was caused by an oversight resulting from a failure of communication internally. We are taking all the steps we know how to prevent a future failure due to similar causes in other programs. In the case of Skylab, without excusing the failure, we are proud of the response of the NASA and industry team to the situation created by the failure, a

response which turned what would have been an aborted mission into the highly successful Skylab 2.

Mr. Chairman, this completes my statement.

The CHAIRMAN. Well, thank you very much, Dr. Fletcher. And I am sure that we all rejoice with you that the competence and dedication of the NASA team was able to redeem the mission and turn it into a great success, in some respects maybe even a greater success because of the adversity suffered in the first place.

Certainly from the viewpoint of the general public, it has been a greater success because it looked as though things had all gone bad.

You state twice that you are requiring the lessons of the Review Board here to be applied by all of the NASA personnel. Are there specific steps that you have taken to implement the recommendations of the Board?

Dr. FLETCHER. Yes. We sent the letter on July 19, and actually George Low signed the letter, to all of the associate administrators that have to do with programs, and basically we asked them to look at all of their projects, and to look for the possible use of a chief engineer as was suggested in the investigation report, who had the responsibility of technical cognizance without being bogged down with all of the red tape and the administrative responsibilities. There were other suggestions made by the Board having to do with the way data was reduced, which had nothing really to do with the Skylab report, but was mentioned in the discussion. And we asked them to take a look at that.

So, I think they are to reply, yes, and 60 days from the date of this letter we will see what comes out of that. Yes, we do plan to follow up in depth on these recommendations.

The CHAIRMAN. How is the ultimate responsibility for the design deficiency shared between NASA and the workshop contractor? Will the contractor lose any award fee or be penalized in any way?

Dr. FLETCHER. Well, I would like to answer the first part of the question and then let Neil Hosenball, our general counsel, answer the question about the penalties.

On the first part, how is it shared, there is no question but what there were serious lacks of communication both at Marshall Space Flight Center and at McDonnell Douglas Corp., and it is in the same way between the aerodynamics group and the design group in each of the places, and so the fault must be shared. We have to recognize that.

Now, with this in mind we do have to look at the award-fee structure. Neil, would you respond to that?

Mr. HOSENBALL. The NASA Workshop contract is a cost-plus-award-fee kind of contract. At the present time the Board, the Performance Evaluation Board and the award-fee determination official are reviewing the performance of McDonnell Douglas under that contract. There are two milestones, milestone 4 and milestone 5, which are presently under review. Milestone 4 covers the period through flight readiness review, which ended April 20; and milestone 5 covers the period of the first occupancy. They will, under the award-fee mechanism, look at the failure as well as the successes of Skylab and make a determination as to what percentage of fee, what amount of fee,

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McDonnell Douglas would receive under both the milestone 4 and milestone 5 award-fee structure.

The CHAIRMAN. So, there is a review being made, and there is a possibility of penalty, or at least a decrease in the fee because of the failure; is that correct?

Mr. HOSENBALL. Yes, sir, I cannot prejudge how much that would be. That would be the fee determination officials' responsibility, supported by this Performance Evaluation Board.

The CHAIRMAN. And when that Board has made its determination, and the decision, I would like for the committee to be notified of what its decision was in this matter.

Mr. HOSENBALL. Yes, sir.

The CHAIRMAN. Dr. Fletcher, I understand that one of the paragraphs in the original Board report was deleted from this version that I have here. Can you tell us what the paragraph said and why it was deleted?

Dr. FLETCHER. Mr. Lundin will have to explain what was in the paragraph in detail. I can talk more about why it was deleted.

Bruce?

The CHAIRMAN. Mr. Lundin, will you tell us what it is, and then Dr. Fletcher will tell us what explanation there is.

Mr. LUNDIN. The particular paragraph dealt with the use of flight data for both understanding the behavior of a flight vehicle either successful or with flight anomalies present, and the use of flight data in the review and learning process.

On discussion of our report, at the time of our submittal of our report to the Administrator, we recognized this paragraph could well be misunderstood, and did not apply to the Skylab 1 failure. And we thought in the interest of clarity that it would be simplest to delete this nonapplicable paragraph which was originally included as sort of a suggestion for the future.

The CHAIRMAN. Do you have the wording of the paragraph? Is it lengthy?

Mr. LUNDIN. It is a short paragraph. Yes; it reads as follows:

Actual flight data is a unique source of information and should be of special interest to management and required reading for every subsystem engineer. Even on fully successful flights, subsystem engineers should be required to review actual flight data from their system and prepare a brief report on how it worked. The available data from a flight, and what may be learned from it, should not be buried in the memory of a computer.

That was the paragraph.

Dr. FLETCHER. Actually, Mr. Lundin has answered both parts of the question, but I would like to add one point because we took the recommendation seriously even though it was not a part of the investigation. And in George Low's memo to the associate administrators responsible for the programs, I would like to quote the paragraph that relates to that. It is very simply,

The board raised another point in the oral discussion—a point which is not included in the written reports because it had nothing to do with the Skylab 1 failure. It concerned the use of "raw" data. The Board felt that, throughout NASA, we sometimes have a tendency to look at computer printouts and the like, several steps removed from the raw data, and that some of the details of

the data may well be masked. Thus, the Board urged that even on fully successful flights subsystems engineers should always review raw data, or data which has been manipulated only the minimum amount required for calibration purposes.

So, that paragraph was not ignored, and then it was asked that the associate administrators comment on both aspects of the report, both the unwritten and the written.

The CHAIRMAN. So, in your letter that you sent out following this you did comment on the original, at least the import of the original paragraph, and admonish all of the personnel to give attention to the raw data as well as the digested parts that come out?

Dr. FLETCHER. That is correct.

The CHAIRMAN. Well, I think I understand what the paragraph was. Of course, I do not know why it was taken out of the Board Report, but I am glad the subject is not being ignored. Senator Helms, I will give you an opportunity here.

Senator HELMS. Thank you, Mr. Chairman. Dr. Fletcher, I do not want to inhibit any negotiation on the possible recovery in connection with this error, but I would be interested to know if there has been a dollars-and-cents estimate made as to the cost of this error?

Dr. FLETCHER. It is very difficult to make a dollars-and-cents estimate of this particular error. We can say that it is small, because what we do when we estimate the cost of this program is, we allow a very definite contingency for all kinds of mishaps, mishaps in flight, design errors, along the way that have to be rectified and so forth. And I can say at this point that this did not require us, as near as I can tell, to exceed that allowance for contingencies. We see no reason, in other words, to increase our total estimate of the cost of completion of the Skylab.

Senator HELMS. I believe the sense of what was said earlier, and by Mr. Lundin, is it your position that the data that was collected as the result of this error may plus out the loss in information? Is that what you are saying?

Mr. LUNDIN. Not specifically, but I think it is a correct observation, Senator, that we frequently learn more from our failures than our successes, and it is a source of strength for the future.

Senator HELMS. Well, just as a pure layman, I am amazed that that sort of thing does not happen all of the time up there. How about you, Mr. Chairman?

The CHAIRMAN. That is right. I marvel too.

Senator HELMS. I have no further questions.

The CHAIRMAN. Thank you.

I would just say, adding to that, the fact that the second crew could launch at a given time, and go up and find that little, tiny spot in space, and go right to it and dock, is still something that is hard for me to believe could happen almost routinely a mere 15 years into the space age. If you just think for a little while how far out they are into space, and the size of that little workshop there, it is difficult for the layman to appreciate the complexities and skill required to get to it so readily.

Senator HELMS. Well, Mr. Chairman, following up on what you said, I know there are those in this country who condemn the space

program for one Fletcher, has done of Americans it has

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The CHAIRMAN.

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program for one reason or another. But, if the program, Dr. Fletcher, has done nothing else, I think in the minds of many millions of Americans it has given a psychological lift.

I would like to point out that not long ago the astronauts of Apollo 17 went to my State, and I traveled around with them a little while. I wish that all Americans could have seen the reaction of the people there to the type of men these are. They are men who believe in their country, they believe in the future, they believe in their God and they came through as the wholesome side of America. And in this day when so much is being said about our country, I think it is refreshing to have people at NASA to show us that it has a better side.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator.

And thank you, Dr. Fletcher and Mr. Lundin, and all who have come.

It is a heartening thing to come and be able to examine our failures and shortcomings, and get them spelled out and on the record so that we can learn from them. And at the same time we are delighted in the ultimate success of the Skylab mission, which we know will continue with the present crew, and hopefully still another crew to occupy the workshop. And from this will flow information and experimentation that will fill volumes, no doubt, for years to come as we learn more and more about our own Earth, and about the solar system and the universe around us.

Thank you very much. The committee is adjourned.

[Whereupon, at 11:05 p.m., the hearing was adjourned subject to the call of the Chair.]

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Statement of  
Dr. James C. Fletcher  
Administrator

JUL 30 1973

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Committee on Aeronautical and Space Sciences  
United States Senate

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear here this morning for your review of the Skylab 1 Investigation Report and to comment briefly on our reactions to its findings and recommendations.

I would like first to take this opportunity to compliment Mr. Lundin and the members of the Skylab 1 Investigation Board for the thoroughness and technical excellence of their investigation and the timely completion of their task.

Mr. Chairman, we all realize the failure that occurred during the launch phase of Skylab 1 should not have happened. However, it did happen--and the two questions NASA has to answer are (1) why did it happen? and (2) what can we do to prevent a similar situation from happening in the future?

The Skylab 1 Investigation Board concluded that a failure of communications among engineering personnel in various disciplines was the basic cause of the design deficiencies which led to the loss of the meteoroid shield and the subsequent damage to Skylab 1. As stated in my letter of July 19, I have accepted these findings.

In NASA we deal with extremely complex systems and have had, by all standards, an extremely high ratio of success to failure. Nevertheless, a few failures do occur and when they do we inevitably find that somewhere along the line "we did not ask the right questions." We have formal management review procedures both written and oral which give our people in industry and government, at all levels, the opportunity to ask questions about our systems. In almost every instance those procedures, formal and informal, identify potential problems and there is then no question that they are resolved. Unfortunately, "almost" is not enough and in this instance we missed--not through negligence but through an oversight--and the right question was not asked.

The second major question we must ask ourselves is what we can do to prevent this from happening in the future. It is not enough to say that the identical failure will not be permitted to happen again. We cannot dismiss the question because another Skylab orbital workshop of the same configuration will never be launched. We have to learn the full lesson of this failure for the conduct of all our large and complex projects, and see that everything possible is done to prevent the recurrence of a similar oversight.

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to examine their projects in light of the findings of the Board. We will follow up to see that changes in formal management systems are made when required.

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Mr. Chairman, as I have said the failure of the meteoroid shield and the resulting loss of Solar Array System #2 should not have happened, but nevertheless it did. However, as we all know, the Skylab 1 and 2 missions as a whole--far from being a failure--have been a resounding success.

The initial failure brought out the real worth of the NASA team. For ten days Skylab was in a state of crisis. It could have been a complete failure, but we were able to save it. For example, through an extensive and rapid concentration of efforts, we were able to come up with several sunshade devices to alleviate the temperature problem, one of which was successfully deployed by the Skylab 2 crew shortly after docking with Skylab, and another is scheduled to be deployed by the Skylab 3 crew tomorrow. With extremely simple tools--pruning shears, rope and a collapsible tent pole, the Skylab 2 crew were able to free and deploy the remaining solar panel,

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Mr. Chairman, this completes my statement.

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NASA-HQ